Getting something new out of something old

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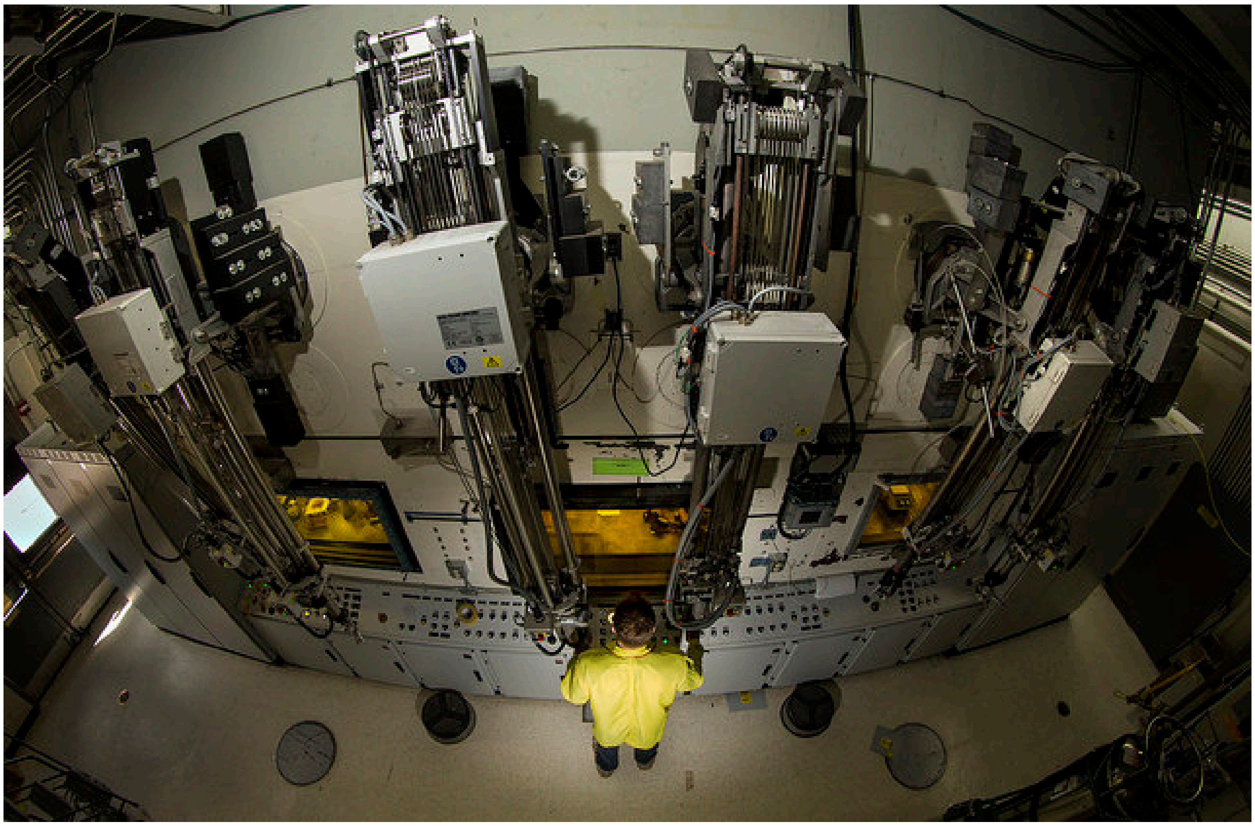

The quest for an imaging radioisotope

One of the challenges in medical imaging is to determine what is happening deep inside the body. Unlike X ray or Magnetic Resonance imaging, nuclear medicine provides insights into the function of the body rather than merely charting its anatomy. Blood flow to the heart, filtration rate of the kidneys and liver function can all be measured using radioactive isotopes that give insight into the actual effectiveness of the organs under assessment.

“In Los Alamos jargon, modern chemistry is often more suspenseful than a spy story. In the search for tiniest cancer foci, for example, researchers send highly specialized spies on a trip: once in the bloodstream, these spies silently trace their target object. Upon arrival, the spies then reveal their location through a distinct, “loud” signal. We’re talking about diagnostic radiopharmaceutical,” observed Michael Fassbender, the lead scientist on the project.

The challenge is that the isotopes used for this work are short-lived, decaying to inactive forms within mere hours or days. This is definitely desirable for the patient's health; at the same time, however, it complicates things on the supplier's side. After all, not everyone can be close to a reactor or accelerator that can make this particular short-lived "spy" that is poised to match the body function to be visually represented. But there's a solution that Los Alamos National Laboratory researchers and their partners are pursuing: There are quite a few radioisotopes among the many isotopes known where a long-lived "parent" decays into a shorter-lived "daughter." Such "parent" isotopes can be the source of functional radioisotopes at facilities that are not in proximity of an accelerator or reactor.

Scientists at Los Alamos are pursing one example of such a long-lived/short-lived isotope system for medical applications in collaboration with colleagues at Brookhaven National Lab. They are producing titanium-44, which has the (very long) half-life of 60 years, using a proton accelerator. From this long-lived "parent" radioisotope, they are attempting to develop a separation of the daughter radioisotope, scandium-44 in what is termed a "generator".

Scandium 44 has a half-life of just under four hours. This is suitable for nuclear medicine studies of processes that take approximately that amount of time such as gastric emptying, bone scans or targeting processes that take hours to maximize. The advantage of the shorter half-life is the ability to capture highly diagnostic images while minimizing the radiation dose to the patient. An added bonus is that, in a so-called "theranostic" approach, diagnostic scandium 44 can be used to stage and plan treatment of cancer and other pathology in combination with a related therapy isotope product, scandium 47.

The challenge is to produce enough of the titanium isotope to enable nuclear medicine studies in multiple sites. A long half-life such as this isotope's means that one needs to produce many radioactive atoms to generate the scandium daughter. The second hurdle for this to become a reliable diagnostic tool is to develop a method to efficiently separate the titanium 44 from its daughter so that the patient does not receive any long-lived parent radioactivity and the radiation dose it would release inside the body.

The research team has made considerable progress to overcome these challenges. They have produced Titanium 44 at the Laboratory's Isotope Production Facility. From this matter, the investigators are developing separation strategies to enable the isolation of pure Scandium 44 for biological studies and potential applications. Successfully solving these technical challenges could enable a valuable addition to the radioisotopes for nuclear medicine imaging.

Los Alamos researchers have recently produced ~ 10 mCi of titanium 44 through the irradiation of two scandium targets at the Isotope Production Facility. As reported at the Pacifichem conference in December, a new separation strategy is being employed to prepare the isotope in high purity. This material is now available for additional studies with generators as well as the scandium 44 daughter.

Los Alamos researchers include V. Radchenko, J. W. Engle, J. R. Maassen, C. M. Naranjo, F. M. Nortier, and M. E. Fassbender (Inorganic, Isotope and Actinide Chemistry, C-IIAC); E. R. Birnbaum and K. D. John (Science Program Office-Office of Science, SPO-SC).

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Research and Applications. The Los Alamos Isotope Program has generated isotopes since the 1970s, with production since 2005 coming from the IPF.

Some related reading on this issue:

Curr Radiopharm. 2012 Jul;5(3):187-201. Scandium-44: benefits of a long-lived PET radionuclide available from the (44)Ti/(44)Sc generator system. Roesch F

Post-elution processing of (44)Ti/(44)Sc generator-derived (44)Sc for clinical application. Pruszy#ski M[1], Loktionova NS, Filosofov DV, Rösch F. Appl Radiat Isot. 2010 Sep;68(9):1636-41